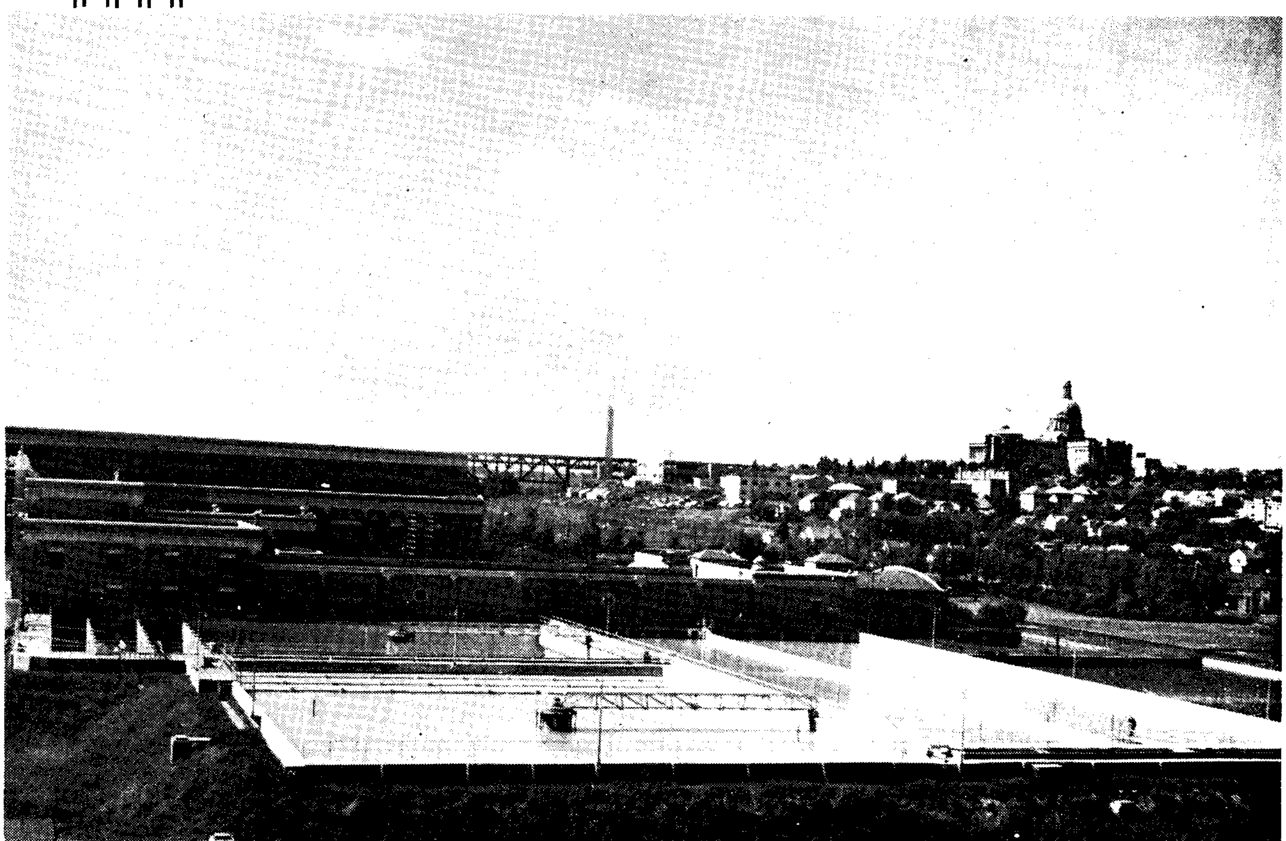
SOFT, PURE WATER

FOR THE

CITY OF EDMONTON



WATER TREATMENT PLANT

CITY OF EDMONTON

POWER PLANT DEPARTMENT

THE EDMONTON WATER TREATMENT PLANT

The following is a brief description of the Water Treatment Plant which was completed in 1948 and which provides water for the City Water System. An outline of treatment methods is also given. In this plant, water from the North Saskatchewan river is softened, clarified, sterilized and delivered into the clear water storage basins for City use.

The softening is accomplished with lime and soda ash. Alum is required in varying amounts for clarification. Activated carbon, when required, is used for taste and odor correction. Chlorine and sulphate of amonia are required for sterilization.

The plant is laid out for handling 15,000,000 Imperial gallons per day. Design of plant requires provision for proper water velocities at the various stages of the process and for the handling of the chemicals and delivery of these into the water.

The plant was built on piles driven to a gravel stratum as the soil above the gravel is alluvial silt and is unstable when wet.

Equipment

The water treatment equipment consists of lime crusher, elevator and storage tank, "Dorrco" slaker, "Omega" belt-type feeder, "Dorrco" sludge pump, "Omega" loss-in-weight soda ash feeder with solution tank, "Dorr" flocculators and clarifiers, CO_2 producer and compressor. All of above have to do with softening.

In addition a belt-type feeder supplies alum as required. Wallace and Tiernan chlorinators and activated carbon feeders complete the chemical feeding equipment. The four filters were designed and equipment supplied by the Roberts Filter Company.

Chemical Handling

Lump lime is delivered to the plant in box cars and manually unloaded into the hammer mill which crushes the lime. It is then elevated to a 75-ton storage tank above the lime feeder. The lime drops from the tank into the belt-type feeder which supplies the lime slaker. The temperature of the slaker is closely controlled and warm water is supplied from the CO_2 scrubber. The solution from the slaker along with some returned sludge from No. 1 clarifier is delivered by the sludge pump to the influent well.

Soda ash is received in 100-lb. paper sacks and is stored on the floor above the feeders. After storage the soda ash requires crushing. The crusher feeds directly into the hopper of the loss-in-weight feeder. The solution from this feeder enters the influent well.

Alum is also stored on the same floor and the sacks are emptied into the hopper of the belt-type feeder.

Carbon dioxide is obtained by burning natural gas, passing the products of combustion through a scrubber and delivering these by compressor to the carbonation chambers. Cooling air from the gas furnace heats the whole building in winter.

Chemical Treatment

Water from the North Saskatchewan river is delivered into the influent well of the plant and all the chemicals are added in this well.

Chlorine and ammonium sulphate are used to sterilize the water, that is, to kill bacteria. They react to form chloramine, which is an active oxidizing agent, and is tasteless and odorless. A residual chlorine recorder continuously records the amount of chloramine in the water as it leaves the plant for the distribution system. As a check on the effectiveness of sterilization, samples are taken three times a week for bacteria examination. One sample is taken of river water and the other taken as the water enters the City system. The University Bacteriological Lab makes a daily test of tap water.

Activated carbon is required only during the spring run-off. It is very finely ground carbon and being very porous, it absorbs into its tiny particles the tastes and odors dissolved in the water. The carbon particles settle out in the clarifier or are filtered off. The source of the color and taste is the early drainage from muskegs.

The scftening process requires that the amounts of calcium bicarbonate, Ca $(HCO_3)_2$, and magnesium sulphate Mg SO_4, be reduced to give the agreed hardness which has been set at 75 p.p.m. average. The average hardness of the river for a normal year is about 183 parts per million. That means 183 lbs. of these hardness forming compounds per million lbs. of water or approximately one ton per million gallons. Slaked lime, $CAOH_2$ (Calcium hydroxide) and soda ash Na_2CO_3 (sodium carbonate) bring about the reduction in hardness.

Calcium bicarbonate and magnesium sulphate are very soluble in water. The softening process changes them to insoluble calcium carbonate and magnesium hydroxide. Being insoluble these latter settle out in the sedimentation basins and are drained away.

The chemical reactions are as follows:

$Ca(HCO_3)_2$	+	$Ca(OH)_2$	$\longrightarrow$	$2\ CaCO_3$	+	$\downarrow$	$2H_20$
Calcium Bicarbonate	+	Calcium Hydroxide		2 Calcium Carbonate		+	2 Water

The arrow indicates the compound settling out.

$MgSO_4$	+	$Ca(OH)_2$	$\longrightarrow$	$Mg(OH)_2$	$\downarrow$	+	
Magnesium Sulphate	+	Calcium Hydroxide		Magnesium Hydroxide		+	Calcium Sulphate

then

$CaSO_4$	+	No_2CO_3	$\longrightarrow$	$CaCO_3$	$\downarrow$	+	Na_2SO_4
Calcium Sulphate	+	Soda Ash		Calcium Carbonate		+	Sodium Sulphate

Mechanical Treatment

The water with all chemicals added upon leaving the influent well goes immediately to the flocculators.

These mechanically driven stirring devices are paddles mounted on a horizontal shaft driven by an electric motor. They thoroughly mix the chemicals with the water. There are three of these flocculators and the water goes from the first to the second then to the third and finally to the first clarifier.

In the forming of any solid from chemical solution, the crystals of the precipitate start to form, then grow in size. Stirring and mixing of any sort assists in this particle growth. The stirring in the flocculators is therefore assisting in the growth of the small calcium carbonate, magnesium hydroxide and aluminum hydroxide particles. All three of these under good conditions will grow to an easily seen size. It is these particles that are called **floc.** It can be seen that a good floc condition is one where the particles have grown large and heavy and so settle readily. Thus the calcium carbonate, magnesium hydroxide and, if

alum is being used, aluminum hydroxide particles, together with mud and color, are ready to settle after passing through the third flocculator.

When the treated water leaves the last flocculator section with a well developed floc, it passes into the No. 1 clarifying and settling tank where the first settlement of sludge takes place. This tank has a central, slowly revolving scraper which draws the settled sludge to the center, where it is discharged through a sewer drain to the river. Not all of this sludge is allowed to be drawn off however, as a considerable quantity of it is pumped back to the influent well; this is done to provide nuclei around which new particles of calcium carbonate and magnesium hydroxide will form, and it is this particle forming and growing that is the most important thing in the stirring stages.

The water on leaving the No. 1 clarifier passes to the first carbonation chamber. Here the excess lime used to create the condition under which the magnesium hydroxide will precipitate is neutralized with carbon dioxide gas.

This neutralization reaction is as follows:

$$Ca(OH)_2 + CO_2 \longrightarrow CaCO_3 \downarrow + H_2O$$

Calcium Hydroxide + Carbon Dioxide → Calcium Carbonate + Water

An excess of 50 to 60 parts per million of slaked lime is found to be sufficient to precipitate the magnesium completely.

The effluent from No. 1 carbonation chamber enters the second flocculator, where the stirring action assists in the formation of calcium carbonate particles produced by the carbonation treatment. Flow from No. 2 flocculator is directly into No. 2 clarifier where settling takes place as in No. 1 clarifier and the sediment is raked by the clarifier into a center well for draining to the sewer.

There will still be in solution a certain amount of calcium carbonate and to prevent this precipitating and forming a crust on filter sand and on the inside of distributing pipes, a second carbonation or re-carbonation is carried out immediately following the discharge from the No. 2 clarifier. This final carbonation treatment by converting the calcium carbonate back to the bicarbonate form, restores the original to the water and removes any flatness that might develop due to the softening. There will then be delivered to the filters a clear, soft, stable water, the palatable properties of which have not been altered in any particular, but whose soluble hardness producing compounds have been greatly reduced.

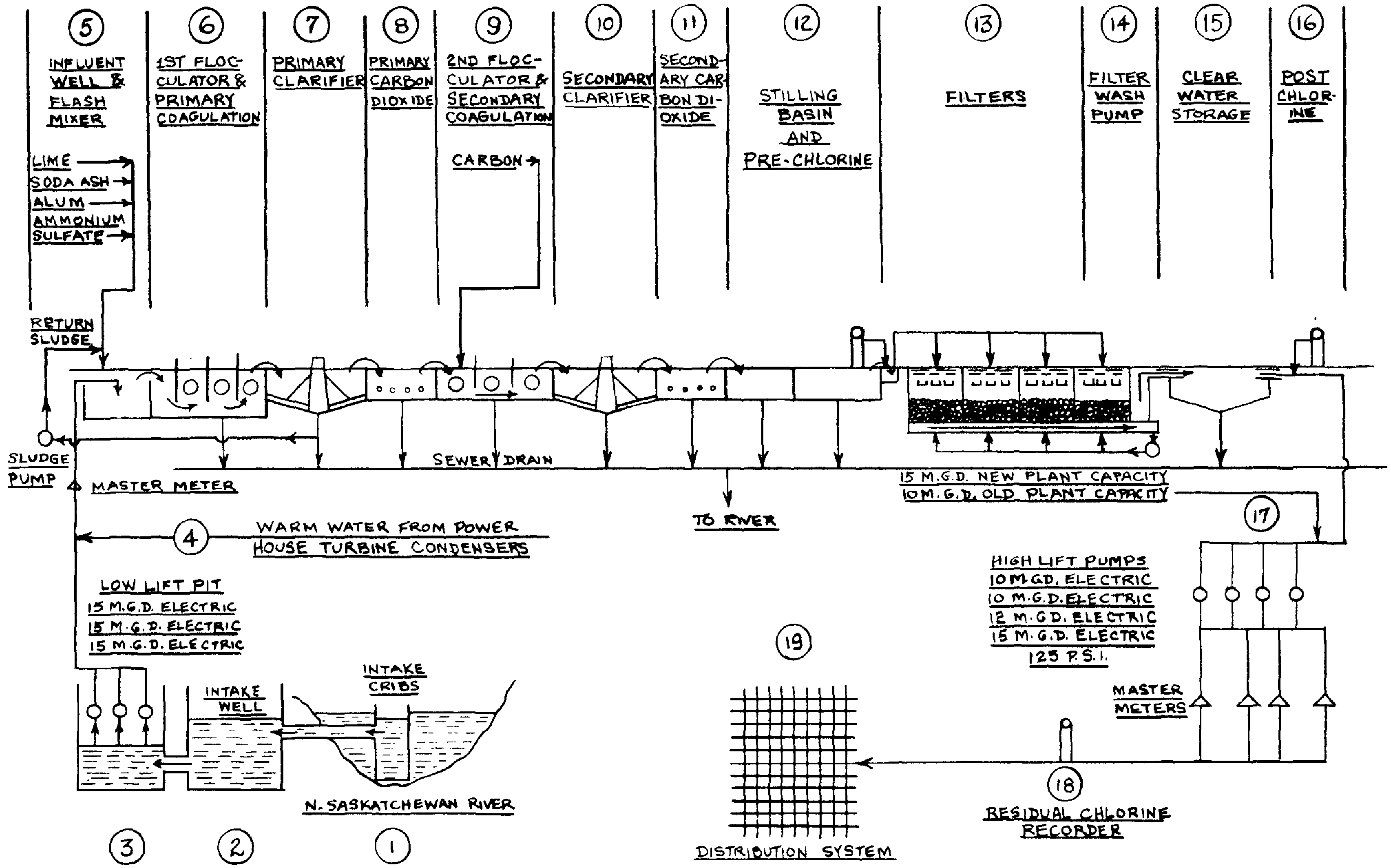
After filtering the water is stored in clear water basins from which the "high lift pumps" pick it up and deliver it to the customer's premises.

By collecting samples at such points as the effluent of the No. 1 clarifier, the effluent of the No. 2 clarifier and the discharge from the filters, and making laboratory tests on these samples, the softening process can be kept under close supervision and the greatest efficiency assured.

The following are some interesting facts covering the water treatment.

Raw Water Analysis	**Average Summer**	**Average Winter**
Carbonate Hardness	98 p.p.m.	142 p.p.m.
Non Carbonate Hardness	40 p.p.m.	86 p.p.m.
Total Hardness	138 p.p.m.	228 p.p.m.
pH	7.9 to 8.1	7.7 to 7.9

Treated Water Analysis	**Year Around Average**
Carbonate Hardness	35 p.p.m.
Non Carbonate Hardness	40 p.p.m.
Total Hardness	75 p.p.m.
pH	8.7 to 9.1



FLOW DIAGRAM EDMONTON WATER TREATMENT PLANT 1953

REVISED JULY '53 F.L